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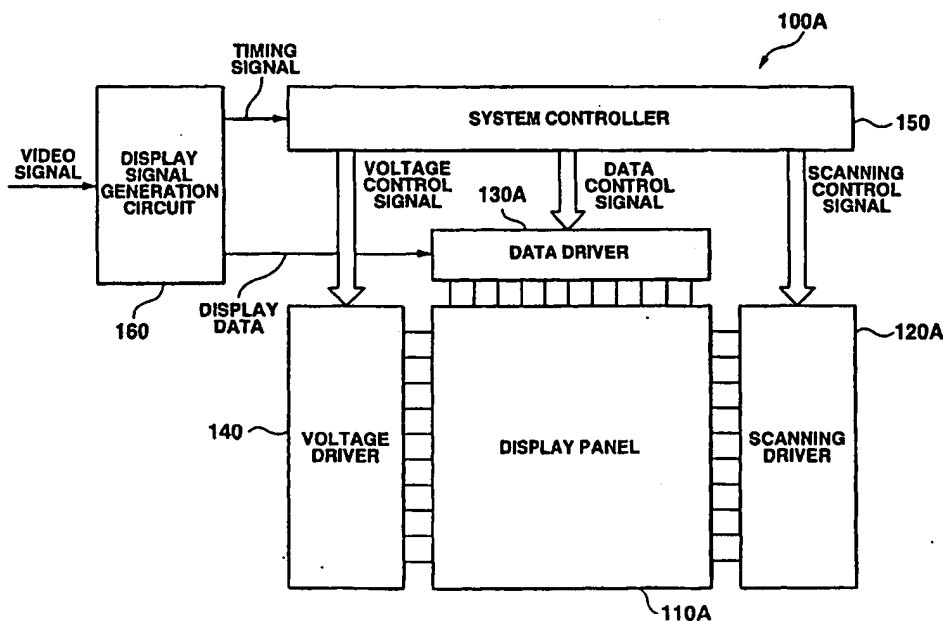
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2003-170376 16 June 2003 (16.06.2003) JP
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- (75) Inventors/Applicants (*for US only*): MOROSAWA, Katsuhiko [JP/JP]; 375-2-6, Kamikitadai 3-chome, Higashiyamato-shi, Tokyo 207-0023 (JP). SHIRASAKI, Tomoyuki [JP/JP]; 1425-3-234, Sakuragaoka, Higashiyamato-shi, Tokyo 207-0022 (JP).
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— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI,

[Continued on next page]

(54) Title: DISPLAY DEVICE AND METHOD FOR DRIVING DISPLAY DEVICE



(57) Abstract: A display device that displays image information in response to a display signal consisting of digital signals includes a display panel comprising a plurality of signal lines (DL) and a plurality of scanning lines (SL) which intersect at right angles with each other, and a plurality of display pixels (EM) with optical element



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# INTERNATIONAL SEARCH REPORT

International Application No.

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**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 G09G3/32

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 G09G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	TAN S C ET AL: "DESIGNING OF CIRCUIT BUILDING BLOCKS FOR OLED-ON-SILICON MICRODISPLAYS" 2002 SID INTERNATIONAL SYMPOSIUM DIGEST OF TECHNICAL PAPERS. BOSTON, MA, MAY 21 - 23, 2002, SID INTERNATIONAL SYMPOSIUM DIGEST OF TECHNICAL PAPERS, SAN JOSE, CA: SID, US, vol. 33 / 2, May 2002 (2002-05), pages 980-983, XP001134332	1,2,4-7, 9,10,12, 13, 16-18, 35-37, 64-67, 69-71
Y	the whole document	19,21, 23-26, 30,31, 38-55, 58,59, 62,63, 72,74, 75,78
-/-		

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
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- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

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- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- \*G\* document member of the same patent family

Date of the actual completion of the international search

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## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/JP 03/13819

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X.	EP 1 039 440 A (SEIKO EPSON CORP) 27 September 2000 (2000-09-27)	1, 3-18, 20, 22, 35-37, 64-66, 68-71
Y	the whole document	19, 21, 23-26, 30, 31, 38-55, 58, 59, 62, 63, 72, 74, 75, 78
P, X	EP 1 282 103 A (SEIKO EPSON CORP) 5 February 2003 (2003-02-05)	1, 2, 4-7, 9, 10, 12, 13, 16-18, 20, 22, 35-37, 64-67, 69-71
	the whole document	
Y	US 2002/135314 A1 (FUJISAWA MASANORI ET AL) 26 September 2002 (2002-09-26) the whole document	19, 39
Y	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 09, 30 September 1996 (1996-09-30) -& JP 08 129359 A (TDK CORP; SEMICONDUCTOR ENERGY LAB CO LTD), 21 May 1996 (1996-05-21) the whole document	19, 39
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Y	EP 1 182 636 A (SEMICONDUCTOR ENERGY LAB) 27 February 2002 (2002-02-27)  the whole document	40-55, 58, 59, 62, 63
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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 03/13819

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 02/17289 A (EMAGIN CORP) 28 February 2002 (2002-02-28)  the whole document	40-55, 58,59, 62,63
Y	EP 0 365 445 A (EASTMAN KODAK CO) 25 April 1990 (1990-04-25)  the whole document	40-55, 58,59, 62,63
Y	GOH J-C ET AL: "A NEW PIXEL CIRCUIT FOR ACTIVE MATRIX ORGANIC LIGHT EMITTING DIODES" IEEE ELECTRON DEVICE LETTERS, IEEE INC. NEW YORK, US, vol. 23, no. 9, September 2002 (2002-09), pages 544-546, XP001125273 ISSN: 0741-3106 the whole document	26,30, 31,55, 58,59, 72,74,75
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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/JP 03/13819

## Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this International application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-18,20,22,35-37,64-71

The first to third concept concern a display with a matrix of pixels with optical elements, a scanning driver circuit, and a signal driver circuit, and current generation circuits comprising

a gradation current generation circuit generating a plurality of gradation currents corresponding to each of the digital display signal bits based on a constant, predetermined reference current, and a drive current generation circuit generating a drive current from the plurality of gradation currents, wherein

- the problem of addressing the optical elements with analog currents corresponding to digital signals at high speed is solved by providing a current generation circuit in the signal driver circuit for each signal line.

1.1. claims: 1-3,64,67,68

The first concept concerns the problem of optical elements requiring a drive current source or sink, which is solved by setting the signal polarity of the drive current supplied to the display pixels side in such a way that the drive current flows in the direction drawn from/poured into the display pixels.

1.2. claims: 1,6-11

The second concept concerns the problem that the digital display signal needs to be stored in the signal driver circuit to enable the provision of the drive current for one scanning period, which is solved by providing a plurality of latch circuits, which hold each bit of the display signal and output it to a switching circuit for selecting the gradation current.

1.3. claims: 1,12,14,15,64-66

The third concept concerns the problem of generating gradation currents with values corresponding to the bits of the digital signal, which is solved by gradation current transistors connected in parallel and having channel width ratios corresponding to the bits of the digital signals.

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2. claims: 1,19,39

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

The fourth concept concerns a display with a matrix of pixels, a scanning driver circuit, and a signal driver circuit, and current generation circuits comprising a gradation current generation circuit generating a plurality of gradation currents corresponding to each of the digital display signal bits based on a constant, predetermined reference current, and a drive current generation circuit generating a drive current from the plurality of gradation currents, wherein

- the problem of addressing the optical elements with analog currents corresponding to digital signals at high speed is solved by providing a current generation circuit in the signal driver circuit for each signal line, the problem of a threshold voltage shift in transistors known as the "kink" phenomenon is solved by any of the reference current transistors or the gradation current transistors or the transistors in the current supply circuit constituting a so-called body terminal configuration as defined in claim 19.

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### 3. claims: 1,21,23-25

The fifth concept concerns a display with a matrix of pixels, a scanning driver circuit, and a signal driver circuit, and current generation circuits comprising a gradation current generation circuit generating a plurality of gradation currents corresponding to each of the digital display signal bits based on a constant, predetermined reference current, and a drive current generation circuit generating a drive current from the plurality of gradation currents, wherein

- the problem of addressing the optical elements with analog currents corresponding to digital signals at high speed is solved by providing a current generation circuit in the signal driver circuit for each signal line,
- the problem of variations of the characteristics of the reference current transistors in the current generation circuit leading to variations in the generated drive current is solved by a current generation circuit, which comprises a reference generation circuit with an electric charge storage circuit and a supply control switching circuit.

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### 4. claims: 1,26-34,64,72-77



## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

The sixth concept concerns a display with a matrix of pixels, a scanning driver circuit, and a signal driver circuit, and current generation circuits comprising a gradation current generation circuit generating a plurality of gradation currents corresponding to each of the digital display signal bits based on a constant, predetermined reference current, and a drive current generation circuit generating a drive current from the plurality of gradation currents, wherein

- the problem of addressing the optical elements with analog currents corresponding to digital signals at high speed is solved by providing a current generation circuit in the signal driver circuit for each signal line,
- the problem of an unstable operating state of the load is solved by a specified state setting/reset circuit in the current generation circuits of the signal driver circuit for applying to the signal lines a specified/predetermined reset voltage.

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## 5. claims: 1,38,64,78

The seventh concept concerns a display with a matrix of pixels, a scanning driver circuit, and a signal driver circuit, and current generation circuits comprising a gradation current generation circuit generating a plurality of gradation currents corresponding to each of the digital display signal bits based on a constant, predetermined reference current, and a drive current generation circuit generating a drive current from the plurality of gradation currents, wherein

- the problem of addressing the optical elements with analog currents corresponding to digital signals at high speed is solved by providing a current generation circuit in the signal driver circuit for each signal line,
- the problem of charges remaining in the optical element and the voltage holding circuit of the pixels is solved by an electric discharge circuit in the pixels for discharging the electric charge stored in the voltage holding circuit and the optical elements.

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## 6. claims: 40-63

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

The eighth concept concerns a display with a matrix of pixels, a scanning driver circuit, and a signal driver circuit, and current generation circuits comprising a gradation current generation circuit generating a plurality of gradation currents corresponding to each of the digital display signal bits based on a constant, predetermined reference current, and a drive current generation circuit generating a drive current from the plurality of gradation currents, wherein the problem of low signal to noise ratio due to the supply of analog signals to the pixels is solved by providing the current generation circuits in each pixel.

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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